

A 1.5 h course to be held at the JRC Ispra at the 5th International Summer School 2013:
Operational Issues in Radioactive Waste Management and Nuclear Decommissioning

Nucleonica “Lab”

Case Study: Characterisation of an irradiated fuel sample (UOX) from a PWR

Dr. Joseph Magill,
Nucleonica GmbH,
Karlsruhe



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NUCLEONICA HOT TOPICS

» **New! Virtual Cloud Chamber**

November 10, 2011

We announce the release of a new Nucleonica module: the Virtual Cloud Chamber. This powerful application is an online interactive simulation tool for investigating the

What is Nucleonica?

- » Nucleonica is an innovative professional and technical resource for knowledge creation and competence building for the worldwide nuclear science community. The portal has grown to become the leading online resource in the nuclear sciences and is particularly suitable for education and training of young scientists, engineers and technicians in the nuclear domain. Our applications enable researchers and specialists to make complex and precise calculations in state-of-the-art fashion.
- » Nucleonica is aimed at scientists, engineers and technical personnel working in the fields of nuclear power, health physics, radiation protection, nuclear and radiochemistry, decommissioning, nuclear medicine, etc. It can be used by professionals for everyday calculations, obtaining quick results and testing, validating and verifying complex computer models.
- » Nucleonica provides you with user-friendly access to the latest reference data from internationally evaluated nuclear data. A unique feature is the wide range of web-based nuclear science applications. A variety of social networking tools are provided for scientific collaboration. In addition, Nucleonica offers a range of

NUCLEAR NEWS

New telescope to guard Earth from killer asteroids

JUN 30 Some 500,000 asteroids are circulating near-Earth space and some of them may pose a real danger to our planet. But a US company says it plans to build a telescope that will be able to watch them. Read [...]

U.N. publishes report on Iran arms trade with Syria

JUN 30 UNITED NATIONS (Reuters) - A U.N. Security Council committee has published a report on Iranian sanctions violations, including shipments of weapons to Syria in breach of a U.N. ban on weapons exports [...]

More firms in danger of systems meltdown, claims risk expert

JUN 30 MORE than half of Irish companies are now at risk of an Ulster Bank-style systems meltdown because they are operating increasingly complicated IT systems – but have failed to commit to the additional [...]

Japan discovers large rare earth deposits

JUN 30 Large and rich rare earth deposits, equaling at least 220 times the country's annual consumption, have been discovered near Minami-Torishima island in the Ogasawara Islands, a research

Case Study: Characterisation of an Irradiated fuel sample (UOX) from a PWR

- A: Calculate the activities of actinide and fission products in the sample (webKORIGEN)
- B: Create a nuclide mixture of the 10 nuclides with highest activities (Nuclide Mixtures)
- C: Estimate the gamma dose rate from this material – both unshielded and shielded (Dosimetry & Shielding)
- D: Generate the gamma spectrum for a HPGe detector (Gamma Spectrum Generator) and identify the main lines.
- E: Generate a transport report to determine which type of packaging is required to transport this sample (e-Ship)
- F: Use the Decay Engine++ to see how the activity of the sample decreases over 5000 y.

1. Open browser and go to www.nucleonica.com

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Thursday, August 08, 2013

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Eu152_GSG_HPGE **Eu152_GSG_NaI**

Cambio File Converter

Counts per keV

Gamma-ray energy, keV

Spectral data at cursor position

Energy, keV	Channel	Counts/keV
344.421	1148	1.59726E+5
344.084	344	3.23782E+4

Gamma Lines near cursor (from standard lib, 580 lines)

Nuclide	Decay	Half-life	Energy, keV	Emission Probability (%)
Pa231	α	32.76ky	340.87	1.740E-01
Eu152	EC	13.33 y	344.28	2.859E+01
Bi210	α	3.00My	344.95	7.629E-01
Pu239	α	24.11ky	345.01	5.580E-04

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- » Nucleonica provides you with user-friendly access to the latest reference data from internationally evaluated nuclear data. A unique feature is the wide range of web-based nuclear science applications. A variety of social networking tools are provided for scientific collaboration. In addition, Nucleonica offers a range of introductory and advanced training courses in various areas of nuclear science.

NUCLEAR NEWS

Job focus: Great prospects for people in power

AUG 8 We've been finding out about saving the planet this week as we have delved into the world of green jobs [...]

Suspected North Korean uranium enrichment

AUG 8 A US think tank says satellite images suggest North Korea may have doubled uranium enrichment capacity at its nuclear complex. [...]

Pacific church leaders want action over Fukushima nuclear waste.

AUG 8 Posted at 06:28 on 08 August, 2013 UTC. The Pacific Conference of Churches says regional leaders must urgently revive calls for a nuclear-free Pacific. The PCC call comes amid revelations by the Japan [...]

A French opinion: Love, jobs and everything else

AUG 8 Who is France's favourite celebrity? Which politician would the French rather go on holiday with? Whatever the question the French seem to produce an opinion poll for it, and summer, it seems, is surv' [...]

27 AUG 8 The world community is being kept in the dark scientifically about the severity and scope of the radiation leaks because TEPCO and the Japanese

NUCLEONICA HOT TOPICS

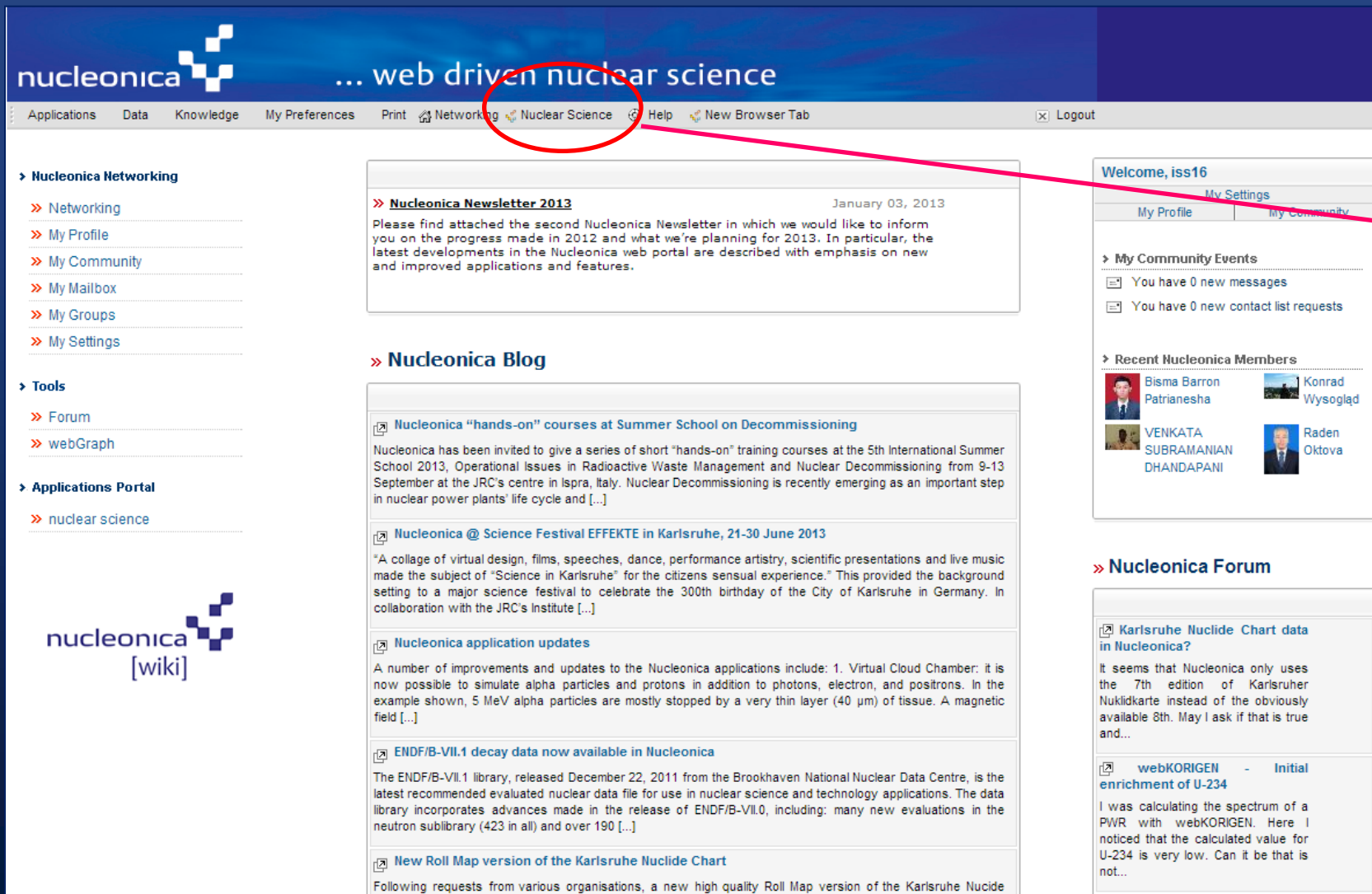
» **Nucleonica Newsletter 2013**

January 03, 2013

Please find attached the second Nucleonica Newsletter in which we would like to inform you on the progress made in 2012 and what we're planning for 2013. In particular, the

2. Enter your username and password (iss*) e.g. iss16

3. You will then enter the Networking page...



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Applications Data Knowledge My Preferences Print **Networking** Nuclear Science Help New Browser Tab Logout

> Nucleonica Networking

- >> Networking
- >> My Profile
- >> My Community
- >> My Mailbox
- >> My Groups
- >> My Settings

> Tools

- >> Forum
- >> webGraph

> Applications Portal

- >> nuclear science

nucleonica [wiki]

>> Nucleonica Newsletter 2013 January 03, 2013

Please find attached the second Nucleonica Newsletter in which we would like to inform you on the progress made in 2012 and what we're planning for 2013. In particular, the latest developments in the Nucleonica web portal are described with emphasis on new and improved applications and features.

>> Nucleonica Blog

Nucleonica "hands-on" courses at Summer School on Decommissioning

Nucleonica has been invited to give a series of short "hands-on" training courses at the 5th International Summer School 2013, Operational Issues in Radioactive Waste Management and Nuclear Decommissioning from 9-13 September at the JRC's centre in Ispra, Italy. Nuclear Decommissioning is recently emerging as an important step in nuclear power plants' life cycle and [...]

Nucleonica @ Science Festival EFFEKTE in Karlsruhe, 21-30 June 2013

"A collage of virtual design, films, speeches, dance, performance artistry, scientific presentations and live music made the subject of "Science in Karlsruhe" for the citizens sensual experience." This provided the background setting to a major science festival to celebrate the 300th birthday of the City of Karlsruhe in Germany. In collaboration with the JRC's Institute [...]

Nucleonica application updates

A number of improvements and updates to the Nucleonica applications include: 1. Virtual Cloud Chamber: it is now possible to simulate alpha particles and protons in addition to photons, electron, and positrons. In the example shown, 5 MeV alpha particles are mostly stopped by a very thin layer (40 μm) of tissue. A magnetic field [...]

ENDF/B-VII.1 decay data now available in Nucleonica

The ENDF/B-VII.1 library, released December 22, 2011 from the Brookhaven National Nuclear Data Centre, is the latest recommended evaluated nuclear data file for use in nuclear science and technology applications. The data library incorporates advances made in the release of ENDF/B-VII.0, including: many new evaluations in the neutron sublibrary (423 in all) and over 190 [...]

New Roll Map version of the Karlsruhe Nuclide Chart

Following requests from various organisations, a new high quality Roll Map version of the Karlsruhe Nuclide





Welcome, iss16

My Settings
My Profile My Community

> My Community Events

- You have 0 new messages
- You have 0 new contact list requests

> Recent Nucleonica Members

 Bisma Barron Patrianesha	 Konrad Wysoglad
 VENKATA SUBRAMANIAN DHANDAPANI	 Raden Oktova

>> Nucleonica Forum

Karlsruhe Nuclide Chart data in Nucleonica?

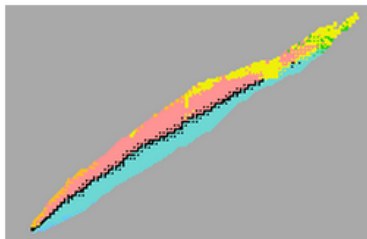
It seems that Nucleonica only uses the 7th edition of Karlsruhe Nuklidkarte instead of the obviously available 8th. May I ask if that is true and...

webKORIGEN - Initial enrichment of U-234

I was calculating the spectrum of a PWR with webKORIGEN. Here I noticed that the calculated value for U-234 is very low. Can it be that is not...

4. Now go to the Nuclear Science page

> Nuclide Explorer



>> Actual Chart: Karlsruhe

> Search Nucleonica Documentation

Nuclide Search / Radiation Search



> Application Centre

- >> New: Mass Activity Converter
- >> Mass Activity Calculator
- >> New: Decay Engine++
- >> Decay Engine
- >> Dosimetry & Shielding
- >> Range & Stopping Power
- >> In Silico Dosimetry
- >> webKORIGEN
- >> Decay Engine for Large Nuclide Sets
- >> Universal Nuclide Chart
- >> New: e-Ship: radiological transport assistant
- >> Transport & Packaging
- >> Nuclide mixtures
- >> Nucleonica Scripting
- >> Gamma Spectrum Generator
- >> Gamma Spectrum Generator Pro
- >> Virtual Cloud Chamber
- >> Cambio file Converter
- >> New: WESPA
- >> Gamma Library
- >> webGraph

> Data Centre

- >> Physical Constants
- >> Nuclide Explorer
- >> New: Nuclide Datasheets++ (Reference Data, Radiations, Derived Data, Cross Sections)
- >> Nuclide Datasheets
- >> New: Nuclide Search / Radiation Search
- >> New: Dose Coefficients
- >> Fission Yields

Welcome, iss16

My Settings
Networking

> My Last Nuclides

27 Co60

> My Nuclide Mixtures

- Natural Potassium
- Fuel element with enriched uranium and ZrH1.6. Total mass is 100 g.
- Rb-81/Kr-81m Generator
- Reactor Grade Pu Sample
- Transuranics in 1 ton Spent Fuel

> My Sources

HEU

> My Messages

No messages for you at the moment

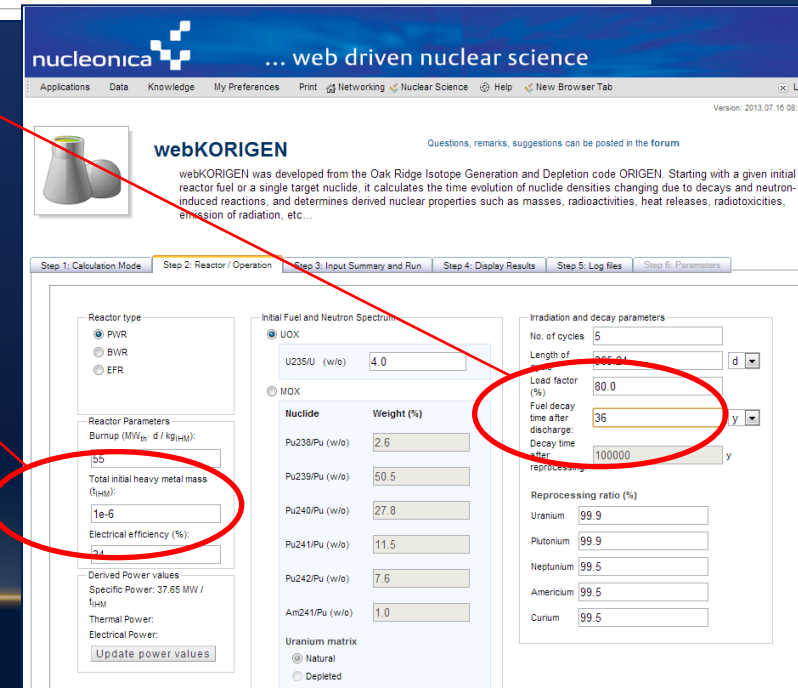
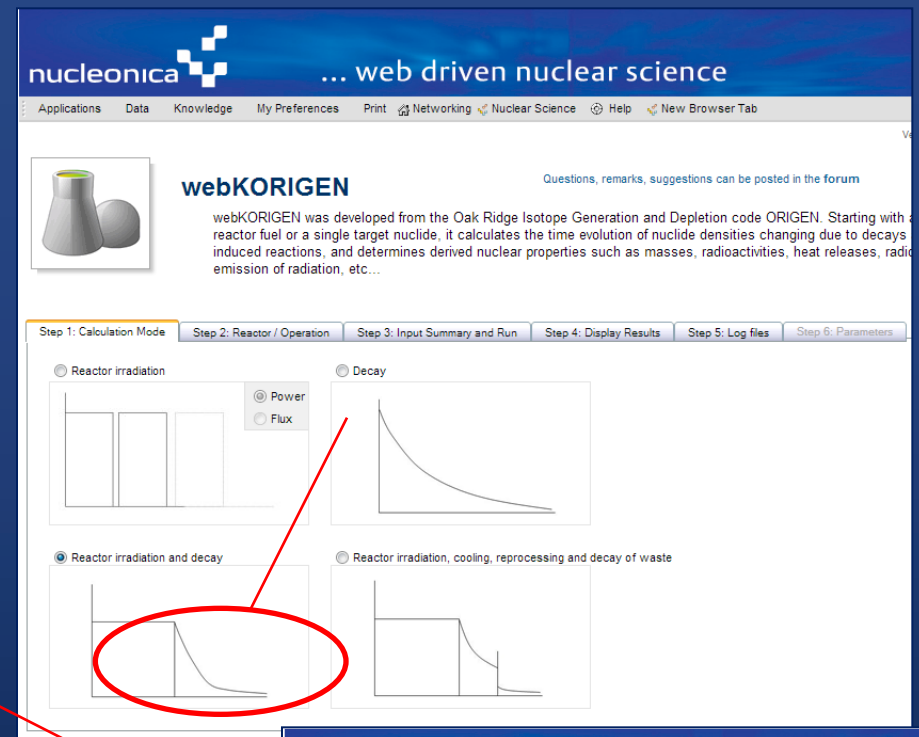
> User Alerts

No alerts at the moment

5. Here are the applications we are going to use

A: Calculate the activities of actinide and fission products in the sample. (webKORIGEN)

1. Start the webKORIGEN application
2. Select mode 3: Reactor irradiation and decay
3. Use a fuel mass of 1g. Take a cooling time of 36 years. Otherwise default values
4. Run the application (go to tab 3)




4. Run the application.

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Version: 2013.07.16 08:39:15



webKORIGEN

Questions, remarks, suggestions can be posted in the [forum](#)

webKORIGEN was developed from the Oak Ridge Isotope Generation and Depletion code ORIGEN. Starting with a given initial reactor fuel or a single target nuclide, it calculates the time evolution of nuclide densities changing due to decays and neutron-induced reactions, and determines derived nuclear properties such as masses, radioactivities, heat releases, radiotoxicities, emission of radiation, etc...

Step 1: Calculation Mode Step 2: Reactor / Operation **Step 3: Input Summary and Run** Step 4: Display Results Step 5: Log files Step 6: Parameters

Input summary

Mode of calculation:	Reactor irradiation and decay
Burnup:	55 MW-d/kg
Reactor type:	PWR
Fuel:	UOX with 4.0% enrichment
Cross Section Library:	<input checked="" type="radio"/> PWR UOX 4.0% U235 60MWd/kgHM <input type="radio"/> PWR UOX high burnup (ORNL)
Operation parameters:	<div>No. of cycles: 5 Length of cycle: 365.24 d Load factor: 80.0 % Fuel decay time after discharge: 36 y Heavy metal mass: 1e-6 t</div>

Run calculation

5. Select activities of the main nuclides (Total activity is 10.6 GBq)

6. Plot the activities over the 36 y cooling period

7. Check the top 10 activities and create a nuclide mixture based on these nuclides. Rename the nuclide mixture.

webKORIGEN

webKORIGEN was developed from the Oak Ridge Isotope Generation and Depletion code ORIGEN. Starting with a given evolution of nuclide densities changing due to decays and neutron-induced reactions, and determines derived nuclear emission of radiation, etc...

Step 1: Calculation Mode | Step 2: Reactor / Operation | Step 3: Input Summary and Run | **Step 4: Display Results** | Step 5: Log files | Step 6: Parameters

Display results for nuclides/elements dominant at 36 y decay

Nuclides/Elements | Radiations | Nuclide Chart

Display quantity: Activity (Bq) | Filter: | **Save as Mixture** (of up to 20 selected Nuclides)

Plot	Z	Nuclides	Results	Plot	Z	Elements	Results
<input checked="" type="checkbox"/>	55	Cs137	2.749e+9	<input type="checkbox"/>	55	Cesium	2.749e+9
<input checked="" type="checkbox"/>	56	Ba137m	2.595e+9	<input type="checkbox"/>	56	Barium	2.595e+9
<input checked="" type="checkbox"/>	39	Y90	1.735e+9	<input type="checkbox"/>	39	Yttrium	1.735e+9
<input checked="" type="checkbox"/>	38	Sr90	1.734e+9	<input type="checkbox"/>	38	Strontium	1.734e+9
<input checked="" type="checkbox"/>	94	Pu241	1.164e+9	<input type="checkbox"/>	94	Plutonium	1.411e+9
<input checked="" type="checkbox"/>	94	Pu238	2.083e+8	<input type="checkbox"/>	95	Americium	1.848e+8
<input checked="" type="checkbox"/>	95	Am241	1.822e+8	<input type="checkbox"/>	96	Curium	9.753e+7
<input checked="" type="checkbox"/>	96	Cm244	9.646e+7	<input type="checkbox"/>	36	Krypton	5.466e+7
<input checked="" type="checkbox"/>	36	Kr85	5.466e+7	<input type="checkbox"/>	63	Europium	4.278e+7
<input checked="" type="checkbox"/>	63	Eu154	4.123e+7	<input type="checkbox"/>	92	Uranium	1.301e+7
<input type="checkbox"/>	94	Pu240	2.529e+7	<input type="checkbox"/>	62	Samarium	1.119e+7
<input type="checkbox"/>	94	Pu239	1.293e+7	<input type="checkbox"/>	1	Hydrogen	3.574e+6
<input type="checkbox"/>	92	U235m	1.292e+7	<input type="checkbox"/>	93	Neptunium	1.997e+6
<input type="checkbox"/>	62	Sm151	1.119e+7	<input type="checkbox"/>	50	Tin	1.092e+6
<input type="checkbox"/>	1	H3	3.574e+6	<input type="checkbox"/>	43	Technetium	7.693e+5
<input type="checkbox"/>	95	Am243	1.974e+6	<input type="checkbox"/>	61	Promethium	5.268e+5
<input type="checkbox"/>	93	Np239	1.974e+6	<input type="checkbox"/>	48	Cadmium	5.131e+5
<input type="checkbox"/>	63	Eu155	1.516e+6	<input type="checkbox"/>	51	Antimony	1.194e+5
<input type="checkbox"/>	43	Tc99	7.692e+5	<input type="checkbox"/>	40	Zirconium	1.037e+5
<input type="checkbox"/>	96	Cm243	7.032e+5	<input type="checkbox"/>	41	Niobium	8.187e+4
<input type="checkbox"/>	0	Totals	1.064e+10	<input type="checkbox"/>	0	Totals	1.064e+10

Page 1/27

Download | Excel | CSV | Comma (",") | Use field qualifier (") | Nuclides | Elements

Plot Nuclides | Plot Elements | Plot Totals | Plot Element Distributions

Nuclides during 36 y decay of 1e-6 tHM PWR UOX 55 MWd/kg

Activity (Bq) dominant at 36 y

Decay time after discharge (y)

B: Create a nuclide mixture of the 10 nuclides with highest activities (Nuclide Mixtures)

1. Rename the mixture to...
1g UOX spent fuel & save

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Nuclide Mixtures

Getting started
Reference manual

My Mixtures Edit Upload Sample Mixtures

Name: **1g UOX Spent Fuel, 36 y decay**

Description: Korigen mode: 3, 36 y decay

Nuclide	Activity(Bq)	Mass(g)	Number of Atoms	Mole	Activity ratio	Mass ratio	Mole ratio	Delete
(add a new Nuclide)								
36 Kr 85	5.471e+7	3.776e-8	2.678e+18	4.447e-8	5.178e-3	1.143e-3	2.362e-3	
38 Sr 90	1.738e+9	3.397e-4	2.275e+18	3.778e-6	0.1643	0.1028	0.2008	
39 Y 90	1.738e+9	8.630e-8	5.781e+14	9.599e-10	0.1643	2.612e-5	5.098e-5	
55 Cs 137	2.751e+9	8.552e-4	3.782e+18	6.247e-6	0.2803	0.2588	0.3317	
56 Ba 137 m	2.597e+9	1.304e-10	5.738e+11	9.525e-13	0.2458	3.945e-8	5.059e-8	
63 Eu 154	4.125e+7	4.124e-6	1.614e+18	2.679e-8	3.904e-3	1.249e-3	1.423e-3	
94 Pu 238	2.082e+8	3.286e-4	8.313e+17	1.380e-6	0.01970	0.09945	0.07331	
94 Pu 241	1.164e+9	3.039e-4	7.593e+17	1.261e-6	0.1101	0.09198	0.08698	
95 Am 241	1.822e+8	1.437e-3	3.590e+18	5.901e-6	0.01724	0.4348	0.3165	
96 Cm 244	9.844e+7	3.203e-5	7.903e+16	1.312e-7	9.127e-3	9.693e-3	6.989e-3	
Total: 10	1.057e+10	3.304e-3	1.134e+19	1.883e-5	1.000	1.000	1.000	

Significant figures: 4

Click on "Total..." to rescale the mixture.

Element: U Mass: 1 Unit: Gram Update

Save Mixture Reset Cancel

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Nuclide Mixtures

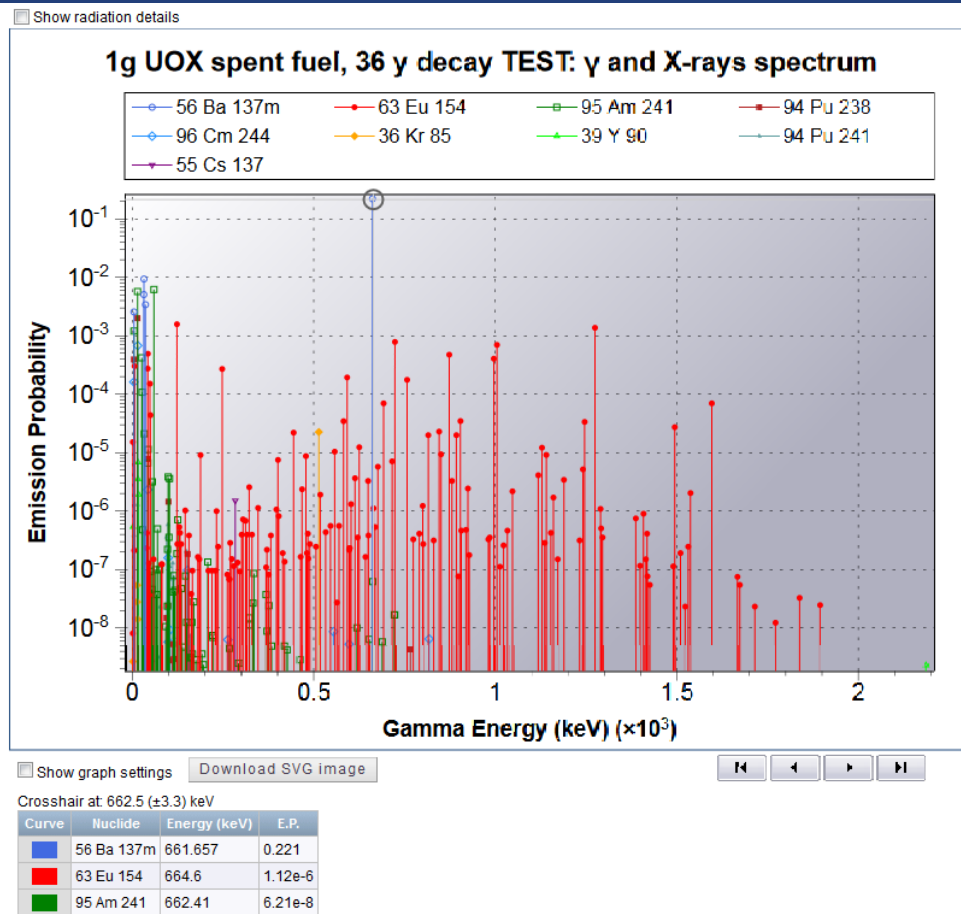
Getting started
Reference manual

My Mixtures Edit Upload Sample Mixtures

User defined nuclide mixtures

Mixture	Date modified	Download	Delete
(create, upload a new Mixture)			
webKorigen nuclides	08.08.2013, 10:58:21		
1 g irradiated UOX fuel	01.08.2013, 10:10:50		
Natural Potassium	23.10.2012, 13:31:19		
Zircaloy-4	10.09.2012, 19:14:17		
Zirconium hydride ZrH1.6	29.08.2012, 11:35:47		
Element Mg	09.08.2012, 19:19:07		
K and its isotopes	09.08.2012, 14:28:47		
SRM 071 U isotopes separated 1. July 1977	28.06.2012, 15:19:14		
Fuel element with enriched uranium and ZrH1.6. Total mass is 100 g.	26.06.2012, 13:58:55		
Fukushima spectrum	22.05.2012, 16:35:01		
Cs137 / Ba137m	02.04.2012, 14:07:29		
Ce-144 / Pr-144	02.04.2012, 14:06:35		
Sr-90 / Y-90	29.03.2012, 14:51:09		
Reactor Grade Pu Sample	10.05.2011, 13:33:12		
HEU, highly enriched uranium	06.05.2011, 13:32:54		
I131_Cs137_mixture	14.03.2011, 16:22:45		
Rb-81/Kr-81m Generator	06.01.2011, 17:03:59		
Natural Uranium	08.04.2010, 15:50:06		
Transuranics in 1 ton Spent Fuel	10.03.2010, 14:31:18		
U232+Co60	10.03.2010, 13:50:08		
Natural Thorium	10.03.2010, 13:36:26		
All Mixtures (21)			

C: Estimate the gamma dose rate from this material – both unshielded and shielded (Dosimetry & Shielding)



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Dosimetry and Shielding++

1g UOX spent fuel, 36 y decay TEST

Mixture: 1g UOX spent fuel, 36 y decay TEST

Nuclide selector

Include daughters

Dosimetry and Shielding Dose rate/Thickness graph Options Mixture details

Initial source strength: Activity(Bq) 1.06e+10

Shielding material: Pb 0 cm

Dose rate ($\mu\text{Sv/h}$): 2.41E+02

Source

Shield

Detector

Source/detector distance (cm): 100

Start Reset

Half-Value Shield Thickness(cm)	9.50E-01
Tenth-Value Shield Thickness(cm)	2.48E+00
Equivalent Dose Rate Constant Γ (mSv-m ² /GBq/h)	2.28E-02
Tissue Gamma Dose Rate (μSv/h)	1.61E+00
Exposure Rate (μ Gy/h)	1.47E+00
Effective Build-up factor	2.85E+00
Effective Number of Mean Free Paths (μ -d)	6.06E+00
<i>Operational Quantities:</i>	
Specific ambient dose rate equivalent h_{10} (mSv/h/GBq) @ 1m	3.51E-02
Specific ambient dose rate equivalent $h_{0.07}$ (μ Sv/h/GBq) @ 1m	< 1.14E+01

Download ☒ Excel ☐ CSV Separator: Semicolon (";") ☐ Use field qualifier ("")

Number of lines (Y):	397	Σ E.P.(Y):	1.85E+06
Number of lines (X):	52	Σ E.P.(X):	2.16E+04
Number of lines (Y+X):	449	Σ E.P.(total):	1.88E+06

Download ☒ Excel ☐ CSV Separator: Semicolon (";") ☐ Use field qualifier ("")

Nuclide	Half-life	Activity (Bq)	Mass (g)	Tissue γ Dose Rate (μ Sv/h)	γ Exposure rate (μ Gy/h)
36 Kr 85	10.776 y	5.49E+07	3.79E-06	7.98E-06	7.25E-06
38 Sr 90	28.79 y	1.74E+09	3.41E-04	0.00E+00	0.00E+00
39 Y 90	64.00 h	1.74E+09	8.66E-03	1.20E-06	1.12E-06
55 Cs 137	30.1671 y	2.76E+09	8.58E-04	7.48E-15	6.45E-15
56 Ba 137m	2.55 m	2.60E+09	1.31E-11	1.18E+00	1.08E+00
63 Eu 154	8.593 y	4.14E+07	4.14E-06	4.32E-01	3.96E-01
94 Pu 238	87.7 y	2.09E+08	3.30E-04	1.60E-07	1.47E-07
10 Nuclides	Page: 1 / 2	1.06E+10	3.31E-3	1.61E+0	1.48E+0

Download ☒ Excel ☐ CSV Separator: Semicolon (";") ☐ Use field qualifier ("")

☒ Show radiation details

Nuclide	Gamma Energy (keV)	Emission Probability P (per disintegration)	Mass Attenuation Coefficient (shielding)(cm ² /g)	Number of Mean Free Paths (μ -d)	Build-up Factor	Mass Absorption Coefficient (tissue)(cm ² /g)	Tissue γ Dose Rate(μ Sv/h)	γ Exposure Rate(μ Gy/h)
56 Ba 137m	661.657	2.21E-01	1.11E-01	6.31E+00	2.83E+00	3.23E-02	1.18E+00	1.08E+00
63 Eu 154	1274.69	1.37E-03	5.81E-02	3.29E+00	2.86E+00	2.93E-02	2.63E-01	2.40E-01
63 Eu 154	1004.57	6.98E-04	7.07E-02	4.01E+00	3.00E+00	3.07E-02	5.67E-02	5.15E-02
63 Eu 154	996	4.06E-04	7.13E-02	4.05E+00	3.00E+00	3.07E-02	3.17E-02	2.97E-02
63 Eu 154	1596.5	7.00E-05	5.08E-02	2.88E+00	2.76E+00	2.76E-02	2.31E-02	2.13E-02
63 Eu 154	873.236	4.74E-04	8.13E-02	4.61E+00	2.98E+00	3.14E-02	1.87E-02	1.71E-02
63 Eu 154	723.43	7.86E-04	1.00E-01	5.68E+00	2.90E+00	3.20E-02	8.81E-03	8.11E-03
63 Eu 154	1494.1	2.73E-05	5.23E-02	2.97E+00	2.80E+00	2.81E-02	8.03E-03	7.60E-03
63 Eu 154	1246.2	3.36E-05	5.90E-02	3.35E+00	2.87E+00	2.94E-02	6.07E-03	5.74E-03

C: Estimate the gamma dose rate from this material – both unshielded and shielded (Dosimetry & Shielding) details

D: Generate the gamma spectrum for a HPGe detector (Gamma Spectrum Generator) and identify the main lines.

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Getting started
Reference manual

Questions, remarks, suggestions
can be posted in the forum

Gamma Spectrum Generator

1 g irradiated UOX fuel

Actual chart: Karlsruhe

Nuclide Mixtures:
1 g irradiated UOX fuel Nuclide Selector

Total activity:
Bequerel 1.057e+010

Reference point:
Measurement start

Measurement setup Calculation results Options

Measurement time: sec 1000 Start

Current configuration: HPGe, coaxial, p-type, rel. eff. 50% (default) Save as Delete

Dimensions in mm

Source

Filter

HPGe

Crystal

59.0

Crystal diameter

10.0

Contact diameter

45.0

Contact length

70.0

Crystal length

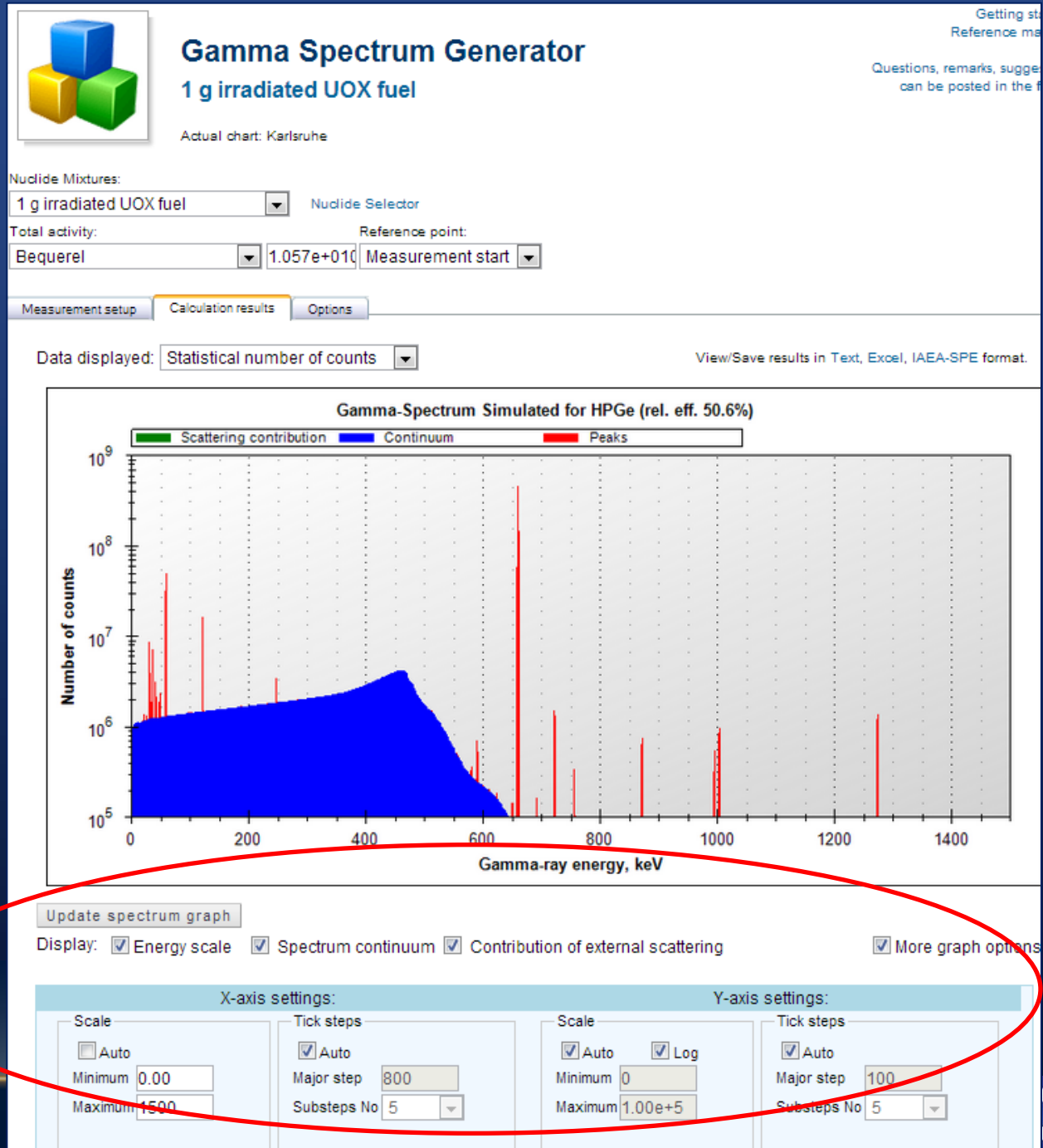
250.0

Source to Detector distance

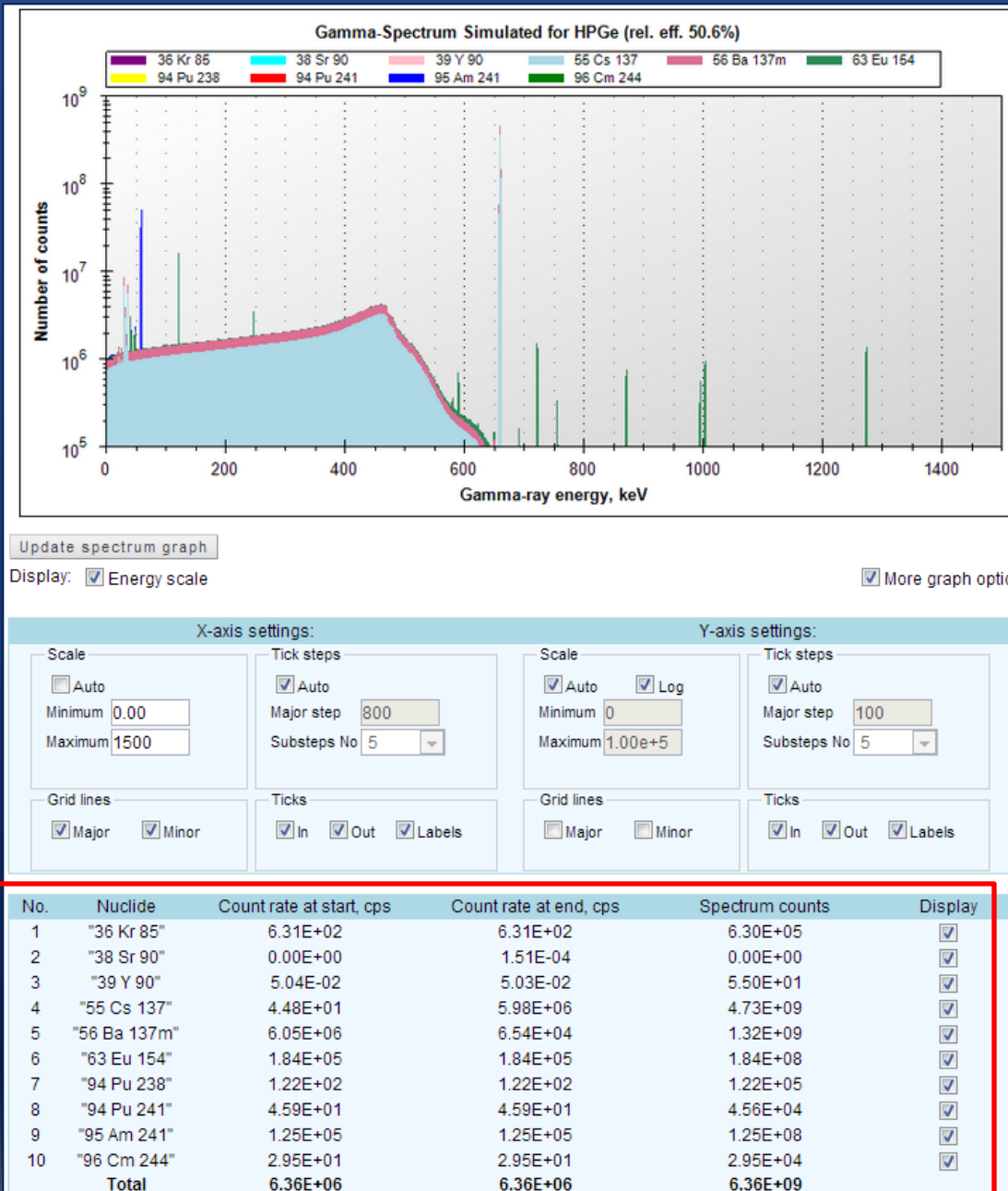
Show more settings

D: Generate the gamma spectrum for a HPGe detector (Gamma Spectrum Generator) and identify the main lines.

Results...



Identify the main lines in the spectrum (use filter shown below the spectrum)




3. Generate the Transport report


(a) A_1 and/or A_2 values include contributions from daughter nuclides with half-lives less than 10 days.
(b) Parent nuclides and their progeny included in secular equilibrium

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F: Use the Decay Engine++ to see how the activity of the sample decreases over 5000 y.

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Decay Engine++

1g UOX spent fuel & save

MixtureNuclide selector

1g UOX spent fuel & save

Decay EngineOptionsDecay TreeMixture details

Starting quantityFinal total quantityUnit

2.93e+91.36E+05becquerel

Decay TimeTime Unit

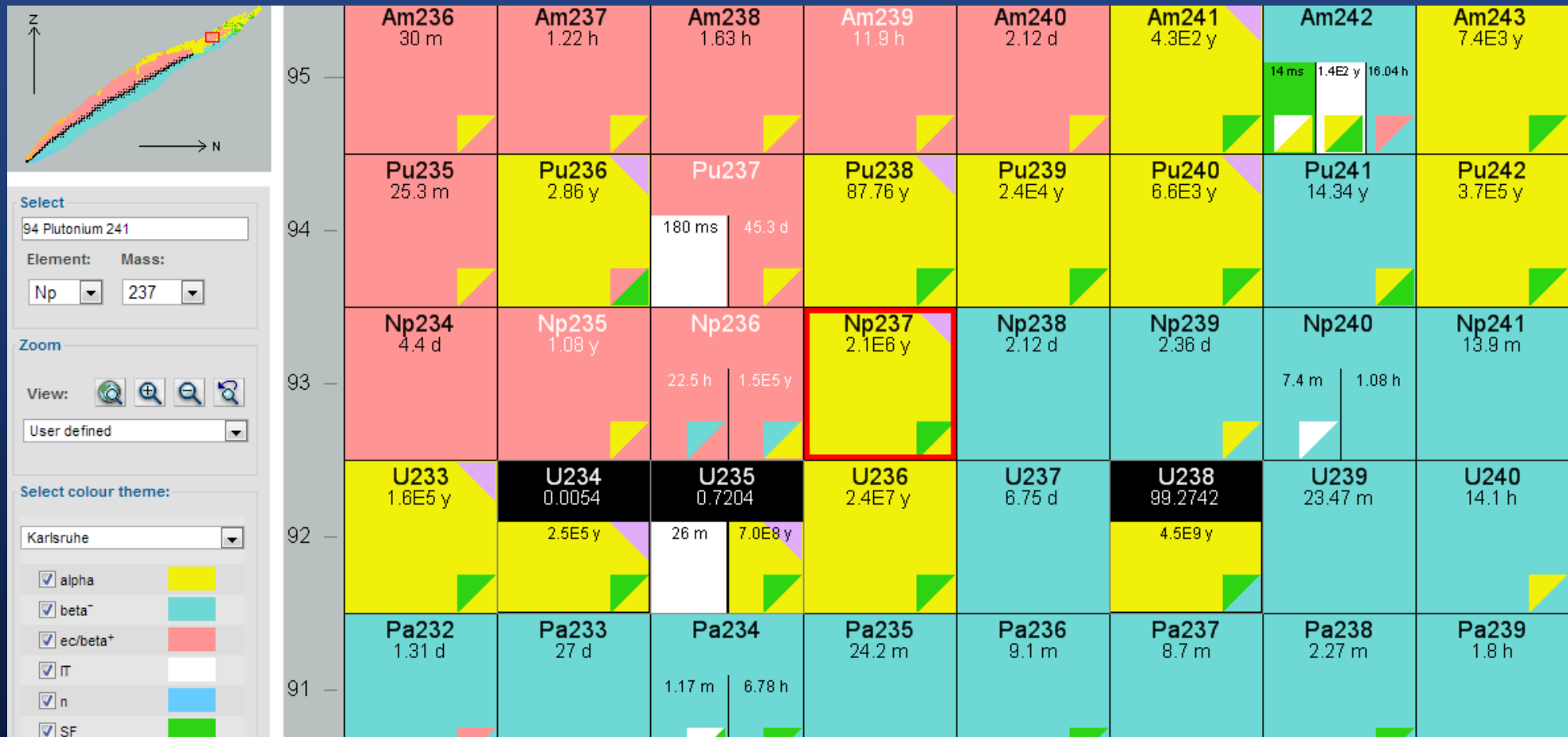
5000year

StartReset

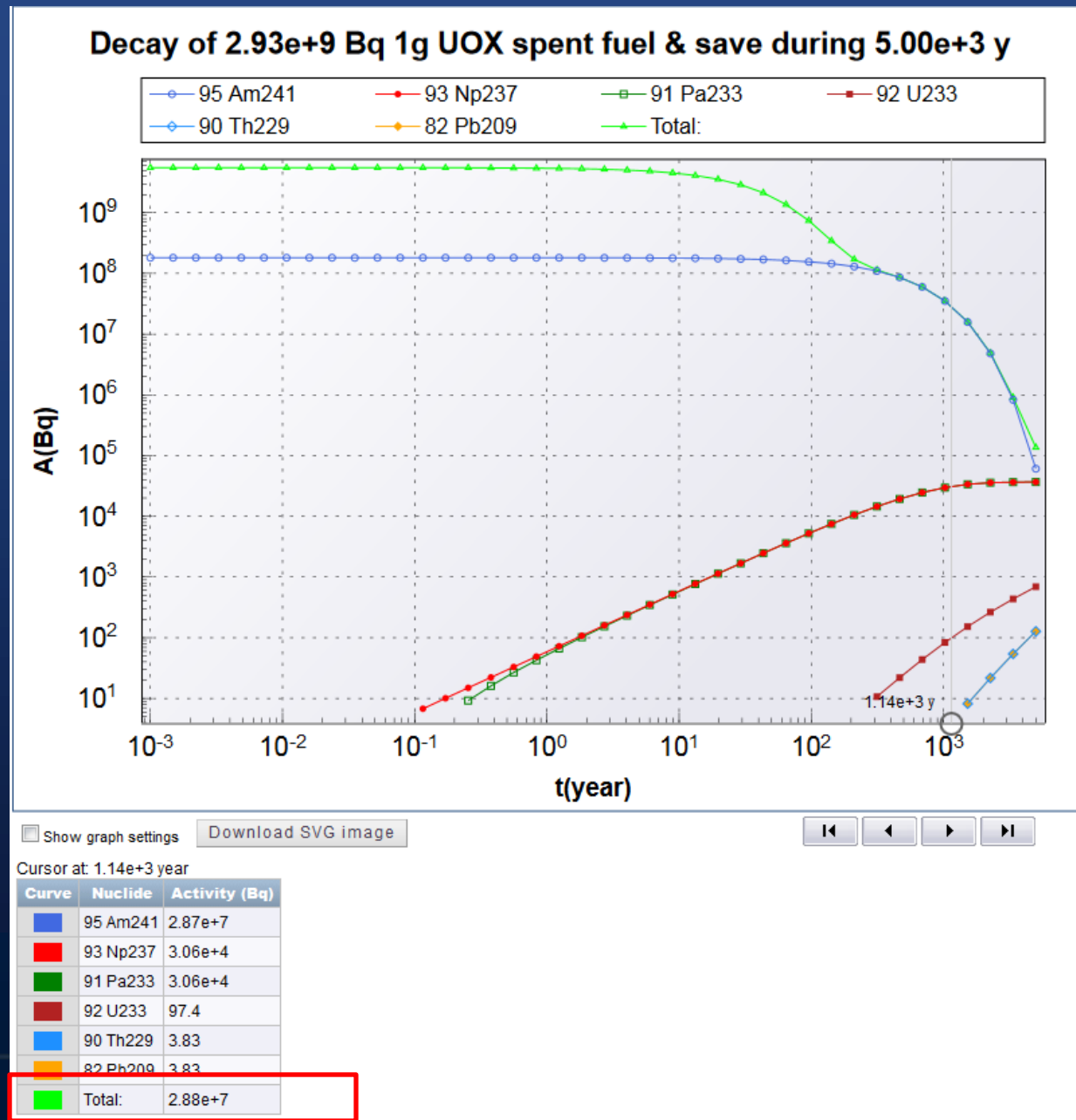
☐ Show rescale tool

Plot	ID	Nuclides	Half-life	Decay modes	Branching Ratio	N(atoms)	Mass(g)	A(Bq)	Ing.Radiot(Sv)
<input checked="" type="checkbox"/>	4	95 Am241	432.8 y	α ; SF; Si34	1; 4.3E-12; 7.4E-16	1.20e+15	4.80e-7	6.09e+4	0.0122
<input checked="" type="checkbox"/>	5	93 Np237	2.14 My	α ; SF; Mg30	1; 1.96E-12; 4E-14	3.58e+18	1.41e-3	3.67e+4	4.04e-3
<input checked="" type="checkbox"/>	6	91 Pa233	27.0 d	β -	1	1.24e+11	4.79e-11	3.67e+4	3.20e-5
<input checked="" type="checkbox"/>	7	92 U233	159.3 ky	α ; SF; Ne24; Mg28	1; 5.92787E-11; 7.2E-13; 1.3E-15	5.03e+15	1.95e-6	693	3.54e-5
<input checked="" type="checkbox"/>	15	82 Pb209	3.253 h	β -	1	2.16e+6	7.49e-16	128	7.28e-9
<input checked="" type="checkbox"/>	8	90 Th229	7.34 ky	α	1	4.27e+13	1.62e-8	128	6.26e-5
<input type="checkbox"/>	9	88 Ra225	14.8 d	β -	1	2.36e+8	8.80e-14	128	1.26e-5
<input type="checkbox"/>	10	89 Ac225	10.0 d	α ; C14	1; 6E-12	1.59e+8	5.95e-14	128	3.06e-6

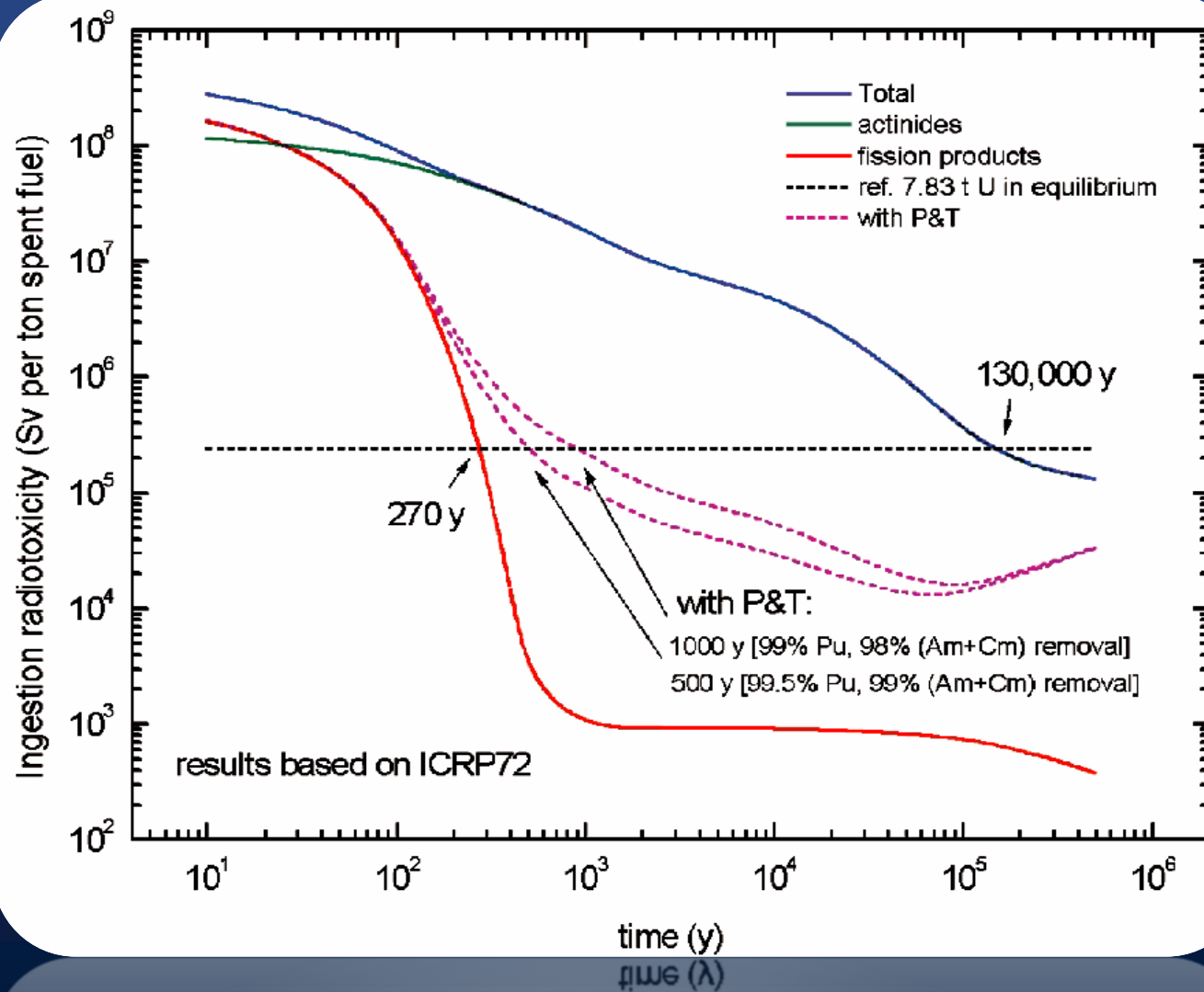
F: Use the Decay Engine++ to see how the activity of the sample decreases over 5000 y.



F: Use the Decay Engine++ to see how the activity of the sample decreases over 5000 y.



Activity
decreases by
factor 100 in
1140 y



Case Study: Characterisation of an Irradiated fuel sample (UOX) from a PWR

- A: Calculate the activities of actinide and fission products in the sample (webKORIGEN)
- B: Create a nuclide mixture of the 10 nuclides with highest activities (Nuclide Mixtures)
- C: Estimate the gamma dose rate from this material – both unshielded and shielded (Dosimetry & Shielding)
- D: Generate the gamma spectrum for a HPGe detector (Gamma Spectrum Generator) and identify the main lines.
- E: Generate a transport report to determine which type of packaging is required to transport this sample (e-Ship)
- F: Use the Decay Engine++ to see how the activity of the sample decreases over 5000 y.